

U.S.S. SCORPION (SSN 589)  
CARE OF FLEET POST OFFICE  
NEW YORK, NEW YORK 09501

SSN589:RRF:lw  
9000  
27 November 1967

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MEMORANDUM

From: Commanding Officer, USS SCORPION (SSN589)  
To: Commander Submarine Squadron SIX

Subj: Background Information on SCORPION Vibration at High Speed

February 1967 - SCORPION drydocked at NNSY. Propeller and shaft were removed for replacement of shaft sleeve in way of sealol seal. Sealol seals and inflatable boot replaced. Visual inspection of shaft, bearings and propeller showed no defects. While in the shop for replacement of the sleeve, the shaft was dropped. No damage was observed.

April 1967 - Shaft was reinstalled in ship. After reinstallation it was found that the sealol seal was improperly installed. This required re-pulling of the shaft to correct the sealol seal installation.

May 1967 - A correct fit per plan could not be obtained during reinstallation of the propeller. After design consultation it was confirmed that the shaft taper was indeed according to plan. Therefore the propeller hub was rebored to match the taper of the shaft. Subsequent reinstallation was satisfactory.

September 1967 - Sea trials were conducted after sitting in wet dock at NNSY for 4 months. Excessive propeller cavitation, coupled with the loss of almost 2 knots at full power from pre-yard experience was observed. On return from trials the propeller and underwater body were inspected by ORION divers, who reported no significant fouling and no damage to the screw.

October 1967 - Enroute to New London for REFTRA the same excessive cavitation and loss of speed were observed. Inspection by SUBASE divers was requested. They reported heavy fouling of the propeller, but scraped off most of the excess. SCORPION was later drydocked in ARD-7 for repairs to #6 torpedo tube stop bolt housing. At this time ship's force and SUBASE propeller shop personnel polished the screw and sharpened the blade edges. One gouge about 4 inches long by one-sixteenth inch maximum depth in the face of one blade was found after the propeller was cleaned. No other defects were observed. The rope guard was removed and a double handful of (b) (7) (D) guidance wire was removed from around the shaft. There was no evidence on careful visual inspection of any wire in the stern tube bearing.

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November 1967 - During the transit and ISE period from New London to Bermuda the ship was again operated at high speed. It was observed that cavitation was still in excess of the ship's pre-yard cavitation curve, but that full speed capability had been regained (a 2 knot increase). No abnormal vibration was observed. During the transit from Bermuda to Roosevelt Roads [REDACTED] the ship refrained from high speed operation.

November 1967 - On 15 November, a week after arrival in Roosevelt Roads and after the firing of [REDACTED] torpedoes had been completed, the ship transitted to St. Croix, Virgin Islands. During this transit it was observed the ship was still capable of speed in excess of [REDACTED] knots, but that a heavy vibration of the ship occurred at speeds greater than about [REDACTED] knots. Above [REDACTED] knots the vibration appeared to diminish slightly. The frequency of this vibration was synchronous with shaft RPM. The nature of the vibration was similar to that of a washing machine with an unbalanced load. It was observed that there was a slight "hunting" of the rudder ram. However, readjustment of the [REDACTED] dither voltage to the control valve eliminated this "hunting" with little effect upon the vibration. AFWR divers inspected the screw in St. Croix and reported no damage.

On 18 November the ship returned to Roosevelt Roads, observing the same phenomenon enroute. On arrival divers again inspected the propeller, and removed a small amount of [REDACTED] wire from the rope guard. They also entered the "mud tank", the free-flooding after portion of the ship surrounding the shaft and rudder and stern plane mechanisms. They found no indication in this area as to the source of vibration. On 19 November the ship again operated at flank speed, and ascertained vibration was still observed at speeds greater than [REDACTED] knots. For this reason a previously planned full power run enroute to Norfolk was cancelled, and ship speed was limited to [REDACTED] knots or less on the return voyage.

Very respectfully,

  
F. A. SLATTERY

Note:

Supplemental information will be provided after ORION dives become available to conduct systematic inspection of stern area.

C.O. opinion is that the vibration is shaft bearing related. This opinion is based on the fact that relocating the point of maximum pressure between shaft and bearing will induce a vibration at almost any speed. For instance, a dead rudder turn causes the ship to heel, which in turn induces a vibration. The vibration is not precisely the same

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RECORD OF ORAL OR TELEPHONIC CONVERSATION  
MARE NORVA

SS(N)-589/5430

Ser 6603-907

19 DEC 1967

Project No: SS(N)-589

Date: Week of 11 December 1967

Medium: Oral & Telephone

Initiated by: Ship's force

With: R. R. Padden (NOME)

Subject: USS SCORPION (SS(N)-589)

Equip/Type: Main Propulsion Shafting

Resume:

1. Problems with shafts and hull vibration were discussed with various members of the ship's force during the week of 11 December 1967. The ship complained of occasional severe vibration of the after section of the hull at what was thought to be once per shaft revolution and NAVSECKORDIV was requested to investigate.
2. Subsequent to the initial inquiry work was done on the main hydraulic system and the system was purged. No difficulty was experienced after above repairs.
3. Further investigation will be held in abeyance pending evaluation of the effect of recent work.

Action taken:

Noted for file.

*R. R. Padden*  
R. R. PADDEN  
HEAD NOME

Encl. (2) to ~~XXXXXXXXXXXX~~ Ser 6603-907



FOR URGENT  
LETTERS ONLY

# NAVAL SPEED LETTER

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IN REPLY REFER TO  
 AS18:11:ajf  
 9000  
 Ser 01556

DATE  
 5 DEC 1967

TO: Commander  
 Submarine Squadron SIX  
 FPO New York 09501

NAVAL SPEED LETTER—

Permits dispatch in informal language.

May be sent (1) with enclosures, (2) in a window envelope (size 8 1/2" x 3 1/4"), if contents are not classified as confidential or higher, (3) to both naval and nonnaval activities.

(Field)

An underwater hull inspection was conducted on USS SCORPION (SSN589) to determine cause of stern vibration. The inspection was completed on 1 December 1967 with the following results:

Visual inspection, by four different divers, of the entire afterbody, revealed no visible cause for vibration.

One section of the propeller rope guard was removed and a dial indicator installed on the bearing housing. The shaft was then rotated two complete revolutions with no visible runout.

Inspection of propeller indicated no external damage or possible cause of vibration.

*J. C. Bellah*  
 J. C. BELLAH

COPY TO

CO, USS SCORPION (SSN589)

ADDRESSEE

Commanding Officer  
 U.S.S. ORION (AS18)  
 FPO New York 09501

SENDER'S MAILING ADDRESS

Address reply as shown on left; or reply hereon and return in window envelope (size 8 1/2" x 3 1/4"), if not classified as confidential or higher.

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Ser 0356

5 DEC 1967

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From: Commander Submarine Squadron SIX  
 To: Commander Submarine Force, U. S. Atlantic Fleet

Subj: USS SCORPION (SSN589) High Speed Vibration; request for technical assistance on (U)

Encl: (1) CO, USS ORION (AS18) spltr 9000 ser 01556 of 5 DEC 67

1. Since completion of planned restricted availability at Norfolk Naval Shipyard in October 1967, SCORPION has experienced excessive cavitation progressing to heavy vibration at high speeds. This letter reviews the background and concludes with a request for technical assistance.

2. A brief history of work accomplished, problems encountered and steps taken to determine the cause are as follows:

a. During RAV shaft and propeller were removed for seal seal replacement. During reassembly a correct fit could not be obtained between the shaft and propeller. Shipyard design confirmed proper shaft taper and the propeller hub was rebored to match the taper of the shaft. Rudder and stern plane readings were within specifications on completion of routine inspection.

b. On sea trials following RAV in September 1967, propeller cavitation was in excess of pre-RAV cavitation curve coupled with a loss of two knots at full power from pre-yard experience. Inspection by divers on return to port revealed no significant underwater fouling or damage to the screw.

c. While in New London for REFTRA, SCORPION was dry docked in ARD-7 for repairs to #6 torpedo tube stopbolt housing. At that time SUB BASE propeller shop polished the screw and sharpened the blade edges. One gouge four inches long by one-sixteenth of an inch deep was the only propeller defect noted. Some torpedo guidance wire was removed from around the shaft on removal of rope guards. There was no evidence of wire in the stern tube bearing.

d. Subsequent to REFTRA a transit was made from New London to Bermuda. Cavitation was still in excess of ships cavitation curve, however, SCORPION full power speed increased two knots to that attained prior to TAV. No abnormal vibration was observed.



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e. An opposed transit was made from Bermuda to Roosevelt Roads and high-speed operations were not conducted. SCORPION operated one week at Roosevelt Roads, firing mines and non-wire guided torpedoes and departed for St. Croix on 15 November 1967. During the transit full power capability did not change, however, heavy shaft vibration developed at about [REDACTED] knots. The vibration diminished slightly above [REDACTED] knots. The nature of the vibration was similar to a washing machine with an unbalanced load and synchronous with shaft RPM. Visual inspection of divers at St. Croix revealed no screw damage.

f. SCORPION returned to Roosevelt Roads 18 November 1967 noting no change from conditions in paragraph i.e. At Roosevelt Roads another underwater inspection was made including entering the free flooding area surrounding the shaft, rudder and stern plane mechanisms. A small amount of torpedo guidance wire was removed from the rope guard. The inspection revealed no other abnormal conditions that might contribute to the heavy vibration.

g. On 19 November SCORPION operated at flank speed noting the same conditions reported in paragraph i.e.

h. SCORPION's speed was held below [REDACTED] knots on her return voyage to Norfolk. A visual inspection of SCORPION's entire afterbody completed 1 December by four different divers, as reported in enclosure (1), revealed no visible cause for vibration. Dial indicator readings taken by the divers from the shaft bearing housing to the shaft showed no discernable shaft run-out. Feeler gauge readings between the shaft and external bearing are within specifications.

3. Commanding Officer, USS SCORPION (SSN589) has been directed to avoid operating in the critical vibration speed range except in emergency conditions.

4. In view of critical forthcoming operations assigned to SCORPION, it is requested that technical assistance be obtained from Naval Ships Systems Engineering Command to conduct onboard inspection and tests inport and underway to determine the cause of excessive vibration and recommend a course of corrective action in order that timely repairs may be made to enable SCORPION to meet her commitments.

J. E. CLARKE, III

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HIGH-SPEED VIBRATION PROBLEM

Having undergone thorough inspection alongside Pier 22, Norfolk by ORION, Squadron and NAVSEC NORVA Division personnel - which disclosed no reason for the vibration - SCORPION got underway on 4 December for scheduled operations. The Commanding Officer had been directed by COMSUBRON SIX to not exceed [REDACTED] knots in view of the undetermined vibration problem.

During this underway period of 4-8 December 1967, SCORPION operated at all speeds up to [REDACTED] knots. At the direction of the embarked Division Commander, COMSUBDIV 62, speed was increased in steps to flank. The ship's performance was observed by ship's company, the Division Commander, and the Squadron Engineer (also embarked) to be normal. Vibration at flank speed and other high speeds was considered to be normal for this ship and class. Acoustic takes were recorded and sent to [REDACTED] [REDACTED], at the Submarine Base New London, for analysis; however, it was expected that the results of his analysis would be inconclusive since the excess vibration was no longer present.

The only physical phenomenon noted as possibly abnormal was a very small (about [REDACTED]), low frequency (about [REDACTED]) oscillation of the rudder ram. This would probably originate in the servo-control loop for the rudder, and may have been caused by small quantities of air in the hydraulic servo-control valve.

The cause of the originally reported vibration remains unknown. Since the ship reported that the hydraulic system had been vented on several occasions since the vibration appeared, it is considered likely that air in the system had affected the servo-loops of the rudder, stern planes, or both, causing the control surfaces to move. In particular, if the surfaces were caused to oscillate at a frequency corresponding to one of the natural vibration frequencies of the hull, a noticeable hull vibration could be expected to result.

[REDACTED]

COMSUBRON SIX Engineer